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Potential Economic Impacts of Draft Restrictions to Address Pesticide Drift and Runoff: Rice Case Study Analysis

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The California Department of Pesticide Regulation (CDPR) released draft use regulations to address pesticide runoff and drift in February 2010. This article considers the potential impacts of regulating two specific active ingredients, propanil and lambda-cyhalothrinin, used in rice production in Butte and Colusa counties. Assuming that the proposed regulations are implemented and changes in rice production in these two counties do not affect the price of California rice, then there would be a loss in total revenues of $7.43 million and a loss in net revenues of $6.25 million. These estimates do not include increased management costs. CDPR is currently reassessing the draft regulations after receiving two rounds of public comments.

Also in this issue

CDPR's draft use regulations, designed to address pesticide runoff and drift, could have a potentially significant economic impact on California agriculture, as well as to the supporting industries and communities, due in part to the large number of active ingredients listed in the draft regulations. Assessing the potential effects of the regulations is complicated by a number of factors.

First, pest management programs for many crops, such as alfalfa, walnuts, strawberries, lettuce, rice and several others, include at least one of the CDPR's targeted 68 active ingredients and efficacious alternatives are not always available. Often, the most common alternatives to an individual active ingredient are also subject to the draft regulations. Second, mandated buffer zones that define the minimum distance that must be left between a sprayed area and a "sensitive aquatic site," as a function of the application method, are an important component of the regulations. Third, the amount of field acreage affected by buffers depends on the distribution of crop acreage relative to the location of a sensitive aquatic site. Fourth, the draft regulations propose to use the definition of sensitive aquatic site as "any irrigation or drainage ditch, canal, or other body of water in which the presence of pesticides could cause adverse impacts on human health or aquatic organisms."

This article focuses on the potential economic impacts of the draft regulations for rice production in Colusa and Butte counties due to the listing of two selected active ingredients. It is drawn from a larger report that considers the economic effects of the draft regulations for 20 county-crop pairs. The analyses are performed at the county level because the distribution of crop acreage relative to the location of sensitive aquatic sites is an important determinant of potential economic impacts.

California Rice Production

According to the National Agricultural Statistics Service (NASS), California's rice crop is the second largest in the United States, accounting for 22% of the value of national rice production. Rice is the tenth most valuable crop grown in California, contributing 2.8% to the total value of production in 2009. In 2009 there were 563,974 acres of rice in California. The statewide average yield was 4.38 tons per acre, production totalled 2,472,614 tons, and the price of rice was $390 per ton with a total farm gate value of $963,526,000.

The top rice-producing counties in California by value are Colusa, Sutter, Butte, Glenn, and Yuba, according to county agricultural commissioners' data reported by NASS. Rice is the most valuable crop in both Colusa and Butte counties. In 2009 rice accounted for

Table 1. Value of Annual Production, Imports and Exports: Rice, 2005–2009

	2005	2007	2009
	----------$1,000----------		
Butte and Colusa Counties	211,048	317,849	427,673
California	467,625	664,538	963,526
Total United States	1,738,598	2,600,871	3,209,236
Imports	224,934	395,473	608,315
Exports	1,277,238	1,392,405	2,175,899

Sources: http://www.fas.usda.gov/gats/ExpressQuery1.aspx
http://nass.usda.gov/Statistics_by_State/California/Publications/AgComm/Detail/index.asp

40.7% and 33.9% of total crop value in Colusa and Butte counties, respectively. Colusa was the top rice-producing county in the state, accounting for 25% of the value of all California rice. In 2009 Colusa County farmers grew 152,400 acres of rice, which yielded an average of 4.5 tons per acre, and produced a total of 685,800 tons of rice; the price was $355 per ton, for a total value of production of $243,459,000.

In 2009 Butte County farmers grew a total of 103,416 acres of rice, which yielded an average of 4.7 tons per acre and produced a total of 486,055 tons of rice; the price was $379 per ton, for total value of production of $103,265,000. Together, Butte and Colusa counties accounted for 44% of California rice production in 2009.

Affected Acreage

According to data from Demars and Zhang (2011), a draft report under preparation for CDFA, there was a total of 250,800 acres of rice in Butte and Colusa counties in 2009, divided among 4,947 different fields. For that report they used Geographic Information System technology to combine U.S. Geological Survey National Hydrography Dataset and California Department of Water Resources land-use layer data into a common projected coordinate system. These were then run through a custom script that reported the amount and percent of crop land bordering sensitive aquatic sites.

Demars and Zhang concluded that while the actual acreage that would be in 25-ft. buffers was a small share of total acreage (0.83%), the number of fields affected was a large share of the total number of fields (87%). Thus, the increased management costs due to the buffers could be substantial. Under a 150-ft. buffer, both the acreage in buffers and the number of fields affected were substantial shares of the total: 19% and 96.5%, respectively.

We used Demars and Zhang's findings, along with base yield information from county agricultural commissioners' reports, cost information from UC Cooperative Extension cost studies, and estimates of yield reduction from the scientific literature to estimate the changes in gross and net revenues for the two counties in response to the regulations.

Analyzed Impacts of Draft Regulations

The most important active ingredients for rice production that would be prohibited for use in buffers under the draft regulations are propanil (Stam 4SC®, Super Wham®), which is used as a cleanup herbicide for weed control, and lambda-cyhalothrin (Warrior II with Zeon®), a pyrethroid insecticide which is used to control rice water weevil.

Weeds are the most important pest in rice, reducing yields by 17% in the United States as a whole (12% in California specifically) compared with 8% and 7% losses yield losses due to insects and diseases, respectively. Thus, weed control through a combination of water management, herbicide application, and other methods is crucial for sustaining the productivity of U.S. rice-cropping systems.

Propanil is the most widely used herbicide in rice. It is a relatively inexpensive material, to which water grass weeds in rice have not yet developed resistance, unlike other available herbicides, including thiobencarb, cyhalofop-butyl, and bensulfuron-methyl. Thus, growers are able to use it as a cleanup herbicide post-planting, following the application of one or more other active ingredients. Most propanil in Butte and Colusa counties is ground-applied, so there is relatively little scope for growers to reduce the impact of the draft regulations by changing from aerial to ground applications. Because of widespread herbicide resistance among common weed species in rice fields, it is difficult to identify post-planting alternatives to propanil as part of an effective weed management program.

There are a few cultural alternatives, including increasing the depth of water in order to "drown" weeds, severely drying the field to desiccate sedges, or using flooding to germinate weeds early and then kill them pre-plant with a broad-spectrum herbicide such as glyphosate. However, none of these methods are a perfect substitute for propanil. Each compromises the efficiency of the production system and may result in considerable yield loss.

In order to compute the effects of the draft regulations on total and net revenues, we specify that propanil is used as a cleanup spray, except in the 25-ft. buffer where no cleanup application is made, and that only half of total field acreage requires a cleanup spray. Based on the scientific literature, we assume that rice yields decline by 40% in the

untreated buffer. The per-acre cost of treatment declines by 100% in the buffer because no cleanup spray is applied. Also, the uncontrolled weeds in the non-treated buffer zones will produce large quantities of seeds, thereby fortifying the weed seed bank and ultimately increasing weed populations over time.

The rice water weevil is one of the most economically damaging invertebrate pests in California rice. Root pruning by larvae reduces growth, tillering, and yield of affected plants. Buffer zone requirements are particularly problematic for rice water weevil management due to its life cycle and distribution in rice fields.

This insect overwinters in grassy areas around rice fields; these areas are usually associated with sensitive aquatic sites such as sloughs and ditch banks. In early spring the rice water weevil moves to flooded rice fields but does not tend to establish very far into the fields. A 25-ft. buffer would encompass most of the area where damage from rice water weevil would be expected to occur.

"The combined revenue losses of the draft regulations, due to changes in application of both propanil and lambda-cyhalothrin, would be a $7.43 million loss in total revenues and a $6.25 million loss in net revenues for Butte and Colusa counties."

Lamda-cyhalothrin is the major insecticide currently used to control rice water weevil. In 2009 all applications of lambda-cyhalothrin in Butte and Colusa counties were made by air, according to CDPR Pesticide Use Reporting data. This is driven by the timing of post-planting applications; rice fields are treated with lambda-cyhalothrin when the rice plants have one to three leaves. At this stage of development, water movement and soil disturbance caused by the equipment used for ground applications can uproot rice plants, reducing stands. Thus, the timing of the application must be changed in order to change the application method and avoid the 150-ft. buffer requirement.

Table 2. Effects of Draft Regulations: Rice in Butte and Colusa Counties (2009 base)

Effect Due to Use Regulations for:	Propanil	Lambda-cyhalothrin	Sum
Acres Impacted (%)	**0.83%**	**19.0%**	
Fields Impacted (%)	**87.0%**	**96.5%**	
Change In:			
County Total Quantity of Rice (%)	-0.4%	-1.3%	-1.7%
Price (%)	0.0%	0.0%	0.0%
County Total Revenues (%)	-0.4%	-1.4%	-1.8%
County Total Revenues ($1,000)	-$1,678.4	-$5,751.5	-$7,430.0
Cost per Affected Acre (%)	-0.5%	-0.5%	-1.0%
County Net Revenues (%)	-0.8%	-2.3%	-3.1%
County Net Revenues ($1,000)	-$1,581.9	-$4,663.5	-$6,245.4

Lamda-cyhalothrin applications made after the three-leaf stage of rice are not effective against the rice water weevil. Recent scientific research findings indicate that pre-flood applications of lambda-cyhalothrin can be effective, although this approach has not been adopted widely by growers.

The UC Integrated Pest Management Guidelines for rice water weevil list two alternative chemical controls to lambda-cyhalothrin: (s)-cypermethrin (Mustang®) and diflubenzuron (Dimilin 2L®). (s)-cypermethrin is a pyrethroid that is also listed in the draft regulations. Hence, it would not be a viable alternative to replace lambda-cyhalothrin if the draft regulations were implemented.

Diflubenzuron is an insect growth regulator and is not listed in the draft regulations. However, diflubenzuron is also not available as an alternative buffer treatment because of label restrictions that require a 25-ft. vegetative buffer between ground application areas and bodies of water. Given these limitations, growers concerned with rice water weevils would likely use a preventive, pre-flood ground application of lambda-cyhalothrin if the draft regulations were implemented.

In order to evaluate the economic effects of the draft regulations on rice water weevil management costs and associated rice revenues, we compare the current post-flood aerial application method to pre-flood ground application to eligible acreage under the draft regulations. Rice water weevils tend to be economic pests near field edges, and growers do not usually treat entire fields.

We proxy this management pattern by assuming that the land within 100 feet of the edge of a field represents, roughly, the land that is treated currently. Under the draft regulations, acreage within 25 feet of a sensitive aquatic site cannot be treated with a ground application. We assume that acreage within this buffer is left untreated, and that lambda-cyhalothrin is ground-applied on the remaining eligible acreage within 100 feet of the field edge. Based on the scientific literature, we assume that the acreage treated with a pre-flood ground application sustains a 15% yield loss and the untreated acreage sustains a 23% yield loss.

Results

In the first scenario, when propanil is no longer applied in the buffer zones

and no other herbicide is used to replace it, we found that total revenues in Butte and Colusa counties would decline by $1.68 million, and that net revenues would decline by $1.58 million, assuming that the price of rice does not increase in response to the 0.4% decrease in production (Table 2).

In the second scenario, with lambda-cyhalothrin ground-applied before planting instead of being aerially applied, and assuming 15% and 23% yield losses as explained above, we found that total revenues in Butte and Colusa would decline by $5.75 million, while net revenues would decline by $4.66 million. Again, this assumes that the price of rice does not change in response to the reduction in quantity of rice produced. The combined revenue losses of the draft regulations, due to changes in application of both propanil and lambda-cyhalothrin, would be a $7.43 million loss in total revenues and a $6.25 million loss in net revenues for Butte and Colusa counties.

Conclusions and Other Policy Considerations

Our analysis indicates that the draft regulations will likely have a substantial negative impact on California rice growers in Butte and Colusa counties, with a decrease in total revenues of $7.4 million and a decrease in net revenues of $6.2 million, if rice prices do not shift because of the decreases in production. The results change substantially (with much smaller revenue decreases and even revenue increases under a few modeled cases) if price is allowed to increase in response to a reduction in quantity of rice in California. However, this is not a very realistic scenario given that rice prices are greatly influenced by world market prices, California only accounts for about one-fifth of U.S. rice production, and the United States is active in the international rice market.

The magnitude of the predicted revenue losses can be accounted for by the fact that there are no ideal substitutes for propanil and lamda-cyhalothrin, the large expected yield losses due to weed and rice water weevil damage in untreated buffer areas, and a sizable amount of rice acreage is affected by the draft regulations. The price of the alternative treatment in comparison to the current treatment is unlikely to be a major factor because farmers will most likely leave buffers untreated with herbicide and switch to ground applications of lamda-cyhalothrin, which involves a negligible increase in per-acre costs. Additionally, because lamda-cyhalothrin also controls tadpole shrimp, another pest of seedling rice, early pest management may become more expensive.

Due to the very high share of fields affected, additional management costs due to the regulations, which are not estimated here, could be substantial. Even if the additional management costs under the draft regulations would be only $100 per field, this would lead to additional revenue losses of $470,000.

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For additional information, the authors recommend:

Goodhue, R.E., P. Howard, K. Klonsky and K. Smoot. 2011. Potential Economic Impacts of the February 1, 2010 Department of Pesticide Regulation Draft Restrictions to Address Pesticide Drift and Runoff to Protect Surface Water: Case Study Analysis. Report prepared for the California Department of Pesticide Regulation, Sept. 9, 2011. Department of Agricultural and Resource Economics, UC Davis. Available at: http://agecon.ucdavis.edu/people/faculty/rachael-goodhue/.

Department of Pesticide Regulation's Draft Restrictions to Address Pesticide Drift and Runoff to Protect Surface Water. February 1, 2010. California Department of Pesticide Regulation. Available at: www.cdpr.ca.gov/docs/emon/surfwtr/regulatory.htm.